Sediment Transport from Urban, Urbanizing, and Rural Areas in Johnson County, Kansas, 2006-2008

Prepared in cooperation with the Johnson County Stormwater Management Program

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Background

- Increased erosion and sediment transport from construction sites is well documented.
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Sediment deposition and stream-channel erosion complicate relations between urbanization and sediment transport in larger basins.
Objective

Characterize how urbanization affects suspended-sediment transport across basin scales

- Small (5-11 mi²) and large (45-65 mi²) basins with similar natural features, but varied stages of urbanization were monitored

- Turbidity sensors were used as a surrogate for suspended-sediment concentration and were coupled with stage to compute sediment loads across space and time
Continuous turbidity monitoring
Study area

- Range of land-use and watershed sizes

- Similar topography and soils across county

- Urban construction quantified using annual changes in impervious surface (Lee and others, 2009; Rasmussen and others, 2008)
Turbidity is an effective surrogate for suspended sediment

\[ \log(\text{SSC}) = 0.98 \times \log(\text{Turb}) + 0.28 \]

Coefficient of determination \((R^2)\) = 0.93

Number of samples = 95

Mean-square error = 0.01

Bias correction factor (Duan, 1983) = 1.03

Site

- CL1
- CL2
- CD1
- LM1
- LM2
- MI3
- MI4
- MI5

95% prediction interval
Regression fit
Stormflow hydrograph at small urban and construction-affected basins

More stormflow, and larger peak-flows at urban site
Sediment transport limited by available supply in urban basin
Typical construction-affected turbidigraph – transport limited

Larger, extended, turbidity conditions at construction-affected site
Relatively dry year, small streamflow and sediment yields

More flow from urban basin, Similar sediment yields
Wet year, more flow/sediment downstream results in larger sediment loads.

Mean precipitation - 40.2 in.

Construction results in larger downstream sediment loads.

Streamflow yield

Sediment yield

Small rural

n = 1

Small urbanizing

n = 2

Small urban

n = 3

Mean precipitation 40.2 in.
2\textsuperscript{nd} wet year, less sediment at urbanizing sites

- **Mean precipitation**: 40.2 in.

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**Streamflow yield**

**Sediment yield**

- **Small rural**: n = 1
- **Small urbanizing**: n = 2
- **Small urban**: n = 3
Annual mean from 2006-2008
Large urban basin transports most flow and sediment

Streamflow yield
Sediment yield

<table>
<thead>
<tr>
<th>Region</th>
<th>n</th>
<th>Streamflow yield</th>
<th>Sediment yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small rural</td>
<td>1</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>Small urbanizing</td>
<td>2</td>
<td>700</td>
<td>150</td>
</tr>
<tr>
<td>Small urban</td>
<td>3</td>
<td>600</td>
<td>120</td>
</tr>
<tr>
<td>Large rural</td>
<td>3</td>
<td>450</td>
<td>90</td>
</tr>
<tr>
<td>Large urbanizing</td>
<td>1</td>
<td>300</td>
<td>60</td>
</tr>
<tr>
<td>Large urban</td>
<td>1</td>
<td>1,500</td>
<td>300</td>
</tr>
</tbody>
</table>
General conclusions

- Construction activity was a substantial source of suspended-sediment in small (5-11 mi\(^2\)) basins
  - Despite improved management practice and dilution from intermediate basin
  - Sediment concentrations at construction-affected sites were larger among both stormflow and low-flow conditions
- Among larger (45-65 mi\(^2\)) basins, the oldest urban basin had 2-10 times larger sediment yields than urbanizing or rural basins
  - Sediment deposition, resuspension, and channel erosion have more influence on sediment transport
Report/Contact Info

Report available online

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